

At the close of the Congress addresses were given to the working classes of the town of Bolton. The Sanitary Institute appears to fully recognize the desirability of bringing home to the minds of all classes of the community the importance of healthy homes and temperate living; and the lesson it should aim at inculcating is that if the public sanitary authorities can do much for the working man, he can do for himself by his own efforts—if he only knew how—very much more to improve his own surroundings, and bring up his family in health and comfort.

The annual visits of the Institute, for the purpose of holding Congresses, to the large towns of this country, must rank as one of the most influential means of popularizing sanitary science. The proceedings of the Congress are watched with interest by persons whose attention it is not easy otherwise to engage; whilst the exhibition of sanitary appliances brings under their notice the latest improvements in domestic and municipal sanitation, and is an incentive to manufacturers to turn out none but the most approved articles.

It also appears that the Institute holds examinations and grants certificates to local surveyors and inspectors of nuisances to sanitary authorities. These examinations should prove of the greatest use to the public sanitary service, for the certificate is a guarantee that the holder possesses sound knowledge on sanitary subjects; and there can in future be no reason why Local Boards should appoint incompetent and ignorant officials, when certificated candidates for office present themselves.

GLEANINGS IN SCIENCE.

Gleanings in Science. By Gerald Molloy, D.D., D.Sc. (London: Macmillan and Co., 1888.)

THIS is a pleasantly-written book, containing ten popular lectures which have, from time to time, been delivered by the author to popular audiences. They were, with one exception, delivered under the auspices of the Royal Dublin Society. The lectures are not offered as containing anything new, but simply as an attempt to popularize some of the most important of modern developments in physical science.

The author has, in our opinion, been thoroughly successful. In a short space he has been able to put before his hearers and his readers, in a satisfactory and thoroughly intelligible manner, a great variety of most important scientific facts and principles. The subjects of the lectures are well chosen.

First, we have two lectures on "Latent Heat," in which the fundamental discoveries of Black are explained and the great results which have flowed from them are recounted. Three lectures on electrical subjects follow. Then we have two lectures on "The Sun as a Storehouse of Energy." Two lectures on the Electric Light enable the author to lay before his readers in a popular but scientific manner the principles of dynamo-machines and the modes of producing the light from the electric current. The transformations of energy which take place during production of the light are also explained. The last lecture is on the Glaciers of the Alps.

The illustrations, which take the place of the experi-

ments of the original lectures, are for the most part suggestive and satisfactory. The lecture on glaciers contains three or four striking, if somewhat sensational, woodcuts by Mr. Whympers, whose Alpine sketches are well known.

A book of the kind we have described is scarcely likely to be absolutely free from blemishes, particularly of style; and there are two or three to which we would call the attention of the author. One of them, at any rate, can be easily amended in another edition. It is the habit of saying "infinitely small" when he means either infinitely small or extremely small. This use of the word indefinite he shares with some, sometimes indefinite, writers on certain branches of mathematics and dynamics. But indefinite does not in pure nor in common language mean infinite; much less can "infinitely small" be put for "extremely small," as in speaking of the length of the path of a molecule. There is nothing indefinite about the path of a molecule any more than about the path of a billiard ball. Again, there is nothing "inconceivable" about the velocity of the radiant energy of the sun (p. 191). It is measurable and well known. The pruning down of some exaggerated language would make the wonders of science all the more wonderful.

A lover of Nature is apt to get into difficulties if he invokes her aid too frequently in descriptions of the physics of our universe. When we read of Nature dealing out the sun's energy *to man* with the prodigality of a spendthrift, we are apt to think of the much more prodigal way in which the sun's energy is poured out all round. The energy which comes in our direction is a very small proportion of the whole. There are too many references to personified Nature in these lectures.

The parts which seem to us least satisfactory are the early part of the lecture on storing of electrical energy, and the classification of the forms of energy contained in the next lecture. The enumeration of various forms of energy available to man is very imperfect. For example, energy of chemical separation is omitted from the list, and yet dynamite, gunpowder, and the gas-engine, are surely worthy of mention. Dynamite is manufactured as electrical energy is; but an engine worked, say, by native petroleum, would be far more efficient than the *earth currents* which Nature provides, but which, as our author properly remarks, are more of a trouble than a pleasure. In another place "bags of oxygen and hydrogen" are referred to as examples of stored-up heat. This seems a little far-fetched, to say the least of it. Just about the same place a rod of "chalk" is used to produce the lime-light.

Perhaps, however, it may seem somewhat ungracious to prolong the list of minor corrections. The book is most readable, and is deserving of praise throughout.

OUR BOOK SHELF.

The Gamekeeper's Manual; being an Epitome of the Game Laws of England and Scotland, and of the Gun Licences and Wild Birds Acts. By Alexander Porter, Chief Constable of Roxburghshire. Second Edition. Pp. 120. (Edinburgh: Douglas, 1889.)

ASSUMING, and we are not in a position to affirm or deny the assumption, that the legal points laid down in this little book are sound, it will certainly fulfil its author's

intention, which, he tells us, is "to place within the reach of all connected with the protection of game a knowledge of the law which it is their duty to administer," and we may hope, also in his words, that it may contribute "to a more effective suppression of a form of lawlessness which leads to so many crimes of a more serious nature." Seeing that it is a second edition, that the author is the head of the constabulary of an important Border county, and that in compiling it he has had the assistance of other chief constables, Mr. Porter is probably right on all points that have been decided. Within his prescribed limits he traces his subject, as it seems to us, very well, though tersely enough, beginning with the earliest records of both Kingdoms, and ending with the silly (but well-meant) Sand Grouse Act which closed the labours of the last session of Parliament—an admirable instance of locking the stable-door after the steed was stolen. However, his treatment is so purely from an executive aspect that comments upon the book are hardly suited to these pages. Yet we may remark that the game law question, which, not so many years ago, was a party cry, has through certain modifications of opinion ceased to occupy that position. There are now few reasonable men who do not perceive that if our ever-increasing population is to continue the enjoyment of the delicacies which "game" (using the word in a wide and not a legal sense) affords, some sort of preservation of such "game" is a necessity. The practical extermination, in many large districts, of *Lepus timidus* since the passing of the Act of 1880 (43 and 44 Vict. cap. 47), leading to the almost prohibitive price of hares in our markets, has fully shown this. The way in which the principle of preservation should be applied is, of course, quite another thing. All men nowadays agree in condemning the savagery of the early laws, though many are apt to forget that it was only of a piece with the savagery of other contemporary laws; but until within the last twenty years few enactments, whether in Great Britain or Ireland, grasped the scientific truth which has been at the bottom of the most recent legislation (the Ground Game Act excepted), and should be at the bottom of all—namely, take care of the parents, and you may leave the offspring to take care of themselves.

LETTERS TO THE EDITOR.

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The Meteoric Theory of Nebulæ, &c.

My last letter in NATURE of March 7 (p. 436) substantially contended that there must be a certain limit to the rate of translatory motion possible to meteoric masses, beyond which they would be rapidly resolved into vapour and consequently be unable to maintain the weight of the heaped-up material constituting the nebula (supposed to be formed of meteorites). It appears tolerably evident that there must be such a limit as to size to which the system can apply, if a period anything like "a few thousand years" mentioned¹ by Prof. G. H. Darwin is to be accorded to this stage of evolution. The doubt was expressed whether the size (or mass) of the original solar nebula was not past that limit, in view of the rate of translatory motion required, viz. $5\frac{1}{2}$ kilometres per second in the mean.

That the theory is in principle true, appears but little open to doubt. For when masses fall in a confused manner to a centre, the kinetic movement is naturally and inevitably produced, and corrected so as to be maintained symmetrically in all directions by the masses themselves. The main question seems to be, What is the limiting mass of the future sun to which such a

¹ Abstract of Mr. G. H. Darwin's paper "On the Mechanical Conditions of a Swarm of Meteorites," appeared in NATURE, November 22 and 29, 1888 (pp. 81 and 105). The complete paper is in the Philosophical Transactions, vol. clxxx., 1889.

system can apply in its completeness; so as to allow anything like permanence enough for the forcible tendency of the energy to equalize itself to extend to a notable radial distance (to settle down into a sort of temporary kinetic equilibrium, that is)? It is conceivable that in the case of an eventual very large sun, the system of meteorites may be heaped up to a certain height, and then collapse at or near the nucleus, where the density is greatest, and consequently the impacts most numerous. Such a partial collapse would give rise to violent oscillation in the nebula, and perhaps assist the throwing off of rings (query). The fact that meteorites are exceptionally the only celestial masses that we can handle and analyze in our laboratories, gives a basis of certainty to inquiries about them, which lends a special interest to theories as to the part played by them in Nature.

In my last letter I avoided the use of the term "elasticity," considering purely the physical conditions which constitute its basis. Prof. G. H. Darwin remarks on this point:—"It may, however, I think, be shown that the very greatness of the velocities will impart what virtually amounts to an elasticity of a high order of perfection" (NATURE, p. 82). "Ordinary elasticity must be nearly inoperative" (p. 107). To produce this exceptional degree of elasticity, the expansive action of the gas generated by the high velocity of impact is relied on, which is regarded to act as "a violent¹ explosive introduced between the two stones." No doubt the volatilized gases due to the collision expand and assist rebound; but in estimating its value we must consider if the chilling of the gas, in doing the work, is at all the equivalent of the heating. If the gas is left in an incandescent state (as is probable, from spectroscopic evidence also), that represents so much spent work, so much² imperfect elasticity. The gas is not confined as in a gun, and so cannot exert its expansive effect to full advantage.

Meteorites constituting a nebula having a mean velocity of $5\frac{1}{2}$ kilometres per second represent an energy about eighty times that of a cannonade. Taking the velocity of an ordinary projectile at 2000 feet per second, that of the meteorites ($5\frac{1}{2}$ kilometres) is 18,000 feet per second, about. Meteorites normally composed of materials imperfectly welded together, cannot stand the same knocking about as steel projectiles. If it were imagined that the latter could have a velocity of 18,000 feet per second imparted to them, they would doubtless leave a luminous track in the atmosphere from friction, and the energy of their mutual collision at this speed may be imagined. It must be remembered, however, that the collisions are generally oblique or glancing.

No doubt in a nebula a metallic rain flying in all directions like the meteorites would accompany the motion. This rain of metal we may suppose under favourable accidents to collide together to form nuclei in various parts of the nebula; and an incipient nucleus constituting a sort of shelter would collect more rain (or hot metal), and so constitute a new meteorite—much as the occasionally dissociated lumps or molecular clusters of a compound gas reunite in another part of the gas, so that the mean state of aggregation remains the same.

The mean interval between encounters depends, of course, on the mean size of the meteorites. It appears from the data afforded that thirty days or a month would be the average interval between collisions (at about one-third radius of the supposed original solar nebula), for meteorites of mean mass equal to $3\frac{1}{2}$ kilogrammes, which would possess a volume of about half a cubic decimetre.³ So that a nucleus, which we may suppose at rest or only slowly moving—as it is, on the average, struck equally on all sides by the metallic rain—would have, as a mean, a month to collect or grow before the chance of being disturbed by a collision in a nebula under the conditions named. In this way, doubtless, nuclei could be formed, and the meteorites renewed.

The question of the applicability of the theory would seem to

¹ The entire passage is: "It must necessarily be obscure as to how a small mass of solid matter can take up a very large amount of energy in a small fraction of a second, but spectroscopic evidence seems to show that it does so; and if so, we have virtually what is a violent explosive introduced between the two stones" (NATURE, November 22, 1888, p. 82).

² It will be seen afterwards that this radiation must not be considered as absolutely lost, but in great part radiated to another region of the nebula of meteorites.

³ For meteorites of $3\frac{1}{2}$ tonnes (about half a cubic metre in volume), the interval between collisions would be 300 days, nearly a year; and the mean length of path 130,000,000 kilometres, nearly the sun's distance. Multiplying the mass by a thousand (or the diameter by 10) increases the interval between collisions and the length of path ten times. At this rate we should get to the stellar distances and stellar movements, regarding the visible universe as a nebula, if a merely speculative remark may be allowed.